Title: Soil as a Natural Filter

Brief Overview:

Most of the time when we speak of water pollution, we only refer to surface water pollution. Many people depend on well water from underground aquifers. Therefore, ground water pollution is a concern, as well. Fortunately, soil acts as a filter. Soil can filter heavy metals, as well as organic and inorganic pollutants. However, there are two main questions to be asked: "how much of these contaminates can soil filter?" and "which soils can filter best?". In order to address these two questions, a soil filtration system can be used.

Links to NCTM 2000 Standards:

- **Mathematics as Communication**
  Students will chart the differences in the concentrations of chemicals before and after soil filtration.

- **Mathematics as Connections**
  Students will use mathematical calculations of concentration differences to show the results of chemical testing and an understanding of mathematical ratios, such as parts per million (ppm).

Links to Maryland High School Mathematics Core Learning Goals:

Data Analysis and Probability

- **3.1**
  Students will collect, analyze, and present data.

Links to National Science Education Standards:

- **Science as Inquiry**
  Students will research the concepts of artesian wells and ground water as it relates to safe drinking water.

- **Science in Personal and Social Perspectives**
  Students will demonstrate the necessity of government policies as they relate to safe drinking water.

Links to Maryland High School Science Core Learning Goals:

- **Skills and Processes**
  Students will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information.

- **Concepts of Earth/Space Science**
  Students will demonstrate the ability to use scientific skills and processes to explain the physical behavior of the environment, earth, and universe.

Grade/Level:

Grades 8 - 9

Duration/Length:

This activity will take one or two 55 minute periods.

Prerequisite Knowledge:

Students should have a working knowledge of the following skills:

- Data collection
- Concentration units, i.e., parts per thousand, parts per million, parts per billion
- Procedures for using chemical test kits

Student Outcomes:

Students will:

- use chemical test kits.
- incorporate basic chemistry.
- determine the effectiveness of soil as a natural water filter.

Materials/Resources/Printed Materials:

- Nitrate test kits
- Motor oil (organic pollutant)
- Cadmium nitrate $Cd(NO_3)_2$
- Sodium sulfide (Na_2S)
- Measurable nitrate source (8 ppm)
- Soil (clay, sand, topsoil)
- Coffee cans, 9 total per group
- Screen (mesh < 0.5 mm), 27 pieces
- 600 mL (or larger) beakers or bowls, 3 per group
- Ring stand, 3 per group

Development/Procedures:

- Wear goggles.
- Line the bottom of 3 perforated coffee cans with 3 layers of fine mesh screen.
- Place sandy soil in can 1, clay soil in can 2, and top soil in can 3 at a depth of at least 25 cm.
- Place each can on a ring stand (you may have to counterbalance the ring stand to accommodate soil weight) over a 600 mL collecting beaker.
- Pour 500 mL of the nitrate solution into each can and allow it to filter into the collecting beakers.
- Use the nitrates kits to test for the nitrates in each collecting beaker.
- Record your results and calculate the difference between the starting and ending nitrate concentrations.
- Using fresh soil (clay, sand, topsoil) in all three cans, repeat the previous steps two more times -- using 500 mL of motor oil as an organic pollutant the second time and cadmium nitrate as a source of heavy metal the third time. Record results.
- Mix sodium sulfide with the collected filtrates from the cadmium nitrate to test for the heavy metal. (A yellow precipitate should form if the filtrate still contains substantial amounts of cadmium.)
- Use a visual method to determine how much oil has been filtered.
- Have students record their finding in a lab book to include observations, data, graphs, analysis, and conclusions.

Assessment:

- Have the students research the chemical composition of the types of soil tested in order to determine what chemical reactions may have taken place to alter the filtrate concentrations. Have the students outline or illustrate those reactions, such as, limestone soil helps counteract the effects of acid rain in lakes and ponds.
- Determine if the physical make up or density of the soil played a role. (This should happen mainly with the oil.)
- Identify the source of the pollutants tested and suggest ways for eliminating the pollutants.
- Research the acceptable levels of the tested contaminates in drinking water. Then determine if soil filters are enough or do extra measures need to be taken. (Remind students that the difference that occurred was at a depth of 25 cm. Most wells are 60 to 450 feet deep.)
- Attach some type of point system to the above four exercises.

Extension/Follow Up:

- Choose different nutrients, i.e., phosphates to filter through the soils and have the students develop or use another chemical test to determine the nutrient composition of the filtrates.

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